Form 8

EFFECT OF DIABETES EDUCATION ON GLYCEMIC CONTROL: REDUCING RISK FOR PERIODONTAL DISEASE

A SENIOR HONORS THESIS

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INTRODUCTION

It is estimated that 9.3% of the American adult population, about 19 million people, are living with type 2 diabetes (1). Of those with diabetes, it is estimated that 6.5% are diagnosed and 2.8% are undiagnosed (1). Furthermore, the prevalence and incidence of type 2 diabetes has been increasing every year (1). Research has shown that type 2 diabetes is a risk factor for periodontal disease (2-7). Furthermore, the incidence of periodontal disease has likewise shown a strong relationship between decreased control over the diabetic condition (8-10). Since it is critical to achieve optimal glycemic control to prevent periodontal disease, the question is whether mindful-meditation along with diabetes education vs. standard diabetes education alone, can help improve glycemic control. If mindful-meditation along with diabetes education proves to be a more effective way of controlling the diabetic state, then it will offer more effective prevention for the incidence and severity of periodontal disease.

LITERATURE REVIEW

Evidence suggests there is a bidirectional relationship between periodontal disease and type 2 diabetes.

Type 2 diabetes and periodontal disease. An assessment of current research shows that type 2 diabetes is a risk factor for periodontal disease. Long-term, poor glycemic control, associated with type 2 diabetes, has been associated with the incidence and progression of diabetes-related complications, including gingivitis, periodontitis and alveolar bone loss (2-3). Furthermore, it has been shown that people with poorly-controlled diabetes have a higher prevalence of severe periodontitis (4). An overall assessment of the available data shows that diabetes is a risk factor for gingivitis and periodontitis (7).

Diabetes is a complex disease characterized by a plethora of co-morbidities that may affect the overall state of periodontitis; however, research has determined a few mechanisms by which diabetes is believed to primarily be able to increase the prevalence and severity of periodontitis. Among the studied mechanisms that increase periodontal disease are vascular changes/abnormalities (11-12), lipid metabolism imbalances (13-15), altered collagen metabolism (16-19), and neutrophil dysfunction (20-21).

Vascular changes / abnormalities. People with diabetes have commonly been known to have many vascular related co-morbidities, which has naturally led researchers to seek a determinable underlying mechanism. Hyperglycemia is a common occurrence for people with diabetes and it is believed that hyperglycemia is among the forerunners for creating vascular dysfunction/abnormalities (11). Hyperglycemia, or elevated blood glucose, exposes more glucose molecules which in turn are susceptible to binding with amino groups of other molecules forming a glycosylation of proteins and lipoproteins (11). When these molecules are glycosylated, they create a group of heterogeneous molecules known as advanced glycation end-products (AGE) (11). Cell membrane proteins have been shown to bind AGEs, these cell membrane proteins are found in the oral cavity and include cells such as endothelial cells, smooth muscle cells, lymphocytes, and monocytes (11). Binding of AGEs to endothelial cells has been shown to cause endothelial activation, a process which causes release of interleukin and tissue necrosis factor (11). This efflux in turn creates increased leukocyte emigration as well as vascular permeability, two factors thought to influence development of periodontal disease (11). Although AGE formation has been linked to a host of other vascular related problems such as retinopathy, atherosclerosis, and renal failure (12), AGE related leukocyte emigration and increased vascular permeability are believed to be precursors to periodontal disease (11).

Lipid metabolism imbalances. Type 2 diabetes has also been associated with hyperlipidemia, a condition hallmarked by excess blood lipids. Hyperlipidemia has led researchers to question whether it is responsible for the underlying mechanisms that cause periodontal disease. Some studies have found that infections can induce general disequilibrium or increase changes in cytokines and hormones which in turn alter lipid metabolism. (13). Altered lipid metabolism leads to the development of hyperlipidemia. People with diabetes, who are subjected to hyperlipidemia, are especially affected by this disruption in fatty acid metabolism (13). It has been shown that as diabetic control diminishes, increases in serum triglycerides ensue (14). When neutrophils, infection fighting cells, in the oral cavity are exposed to increased serum triglycerides they are believed to increase the production of pro-inflammatory cytokines, namely Interleukin-1 beta (IL-1 ß) and Tumor Necrosis Factor-alpha (TNF-α) (14). These cytokines normally offer protection against infection; however, their disequilibrium is believed to be responsible for a diminished reparative response in the oral cavity tissue (15). Therefore, a reduction in reparative function in the oral tissue leads to the increase and prevalence of periodontal disease in people with hyperlipidemia.

Altered collagen synthesis. As mechanistic evidence is suggested as to how diabetes leads to periodontal disease, researchers have begun to focus on the host response to these altering states. Alteration in collagen production, maturation, and turnover are common in diabetes. Because collagen is among the major structural proteins of the periodontum, these changes can contribute to impaired wound healing and increased severity of periodontal disease. Research has found that decreased amounts of collagen and glycosaminoglycans are produced in high-glucose environments, such as hyperglycemia (16). Both collagen and glycosaminoglycans are essential components of connective tissue and their decreased production in elevated glucose environments has been effectively reversed with insulin treatment in non-human models (17). Not only do people with diabetes have decreased collagen production, but also their newly synthesized collagen molecules are more susceptible to degradation (18). It has been found that an elevated level of matrix metalloproteinases (MMPs) accumulate in the diabetic state and these MMPs are capable of degrading newly synthesized collagen, damaging connective tissue (18). To further the complications with collagen synthesis, AGEs alter existing collagen, making it highly crosslinked and very stable (19). The connective tissue in people with diabetes produces less collagen (16), the collagen is more susceptible to degradation (18), and the existing collagen can become crosslinked (19) leading to the build-up of AGE-modified, stable complexes. Therefore, the mechanistic alteration of collagen synthesis may lead to periodontal disease and decreased wound healing.

Neutrophil dysfunction. Neutrophils, a subcategory of leukocytic cells that aid infection fighting in the body, are responsible for aiding in mechanisms such as chemotaxis and phagocytosis (20). Chemotaxis is the body's cellular response to a stimulus, which often includes moving phagocytic cells into the proximity of infectious agents (20). Once cells are in proximity of infectious agents, phagocytosis allows cellular uptake and destruction of these foreign infection particles (20). Because these mechanisms aid in fighting infection, it is highly important for functioning neutrophils to protect the oral cavity and aid in the prevention of periodontal disease. Previous research has shown that people with diabetes are likely to have decreased neutrophilic or polymorphonuclear (PMN) leukocytic functions such as phagocytosis and chemotaxis (21). Therefore, it is no surprise that correlation has been found between decreased PMN leukocytic function and increased severity of periodontal disease (21). Identification of the PMN dysfunction mechanism has led researchers to believe that possibly hyperglycemia, an increased level of blood glucose, is to blame (21). Defects in neutrophilic function possibly due to hyperglycemia, therefore is believed to make people with diabetes also more likely to be susceptible to increases in the incidence and prevalence of periodontal disease.

Periodontal disease: Decreased control of the diabetic state, averse effects. The correlation between diabetes and periodontal disease appears to be bidirectional. Researchers have been investigating the possibility that not only does diabetes lead to the incidence and prevalence of periodontal disease, but also that periodontal disease leads to decreased glycemic control. Decreased glycemic control can lead to hyperglycemia, hyperlipidemia, or dyslipidemia; these co-morbidities of diabetes have been pinpointed as possible mechanistic pre-cursors for periodontal disease. Therefore, people with periodontal disease appear to be predispositioned for diabetes.

Research supports that periodontal infections contribute to complications with glycemic control (8) and some have shown that treating chronic periodontal infections is essential for managing diabetes (22).

Infection induced glycemic control loss. Periodontal disease is often associated with infection, which is considered a possible link to deterioration in glycemic control. Bacterial and viral infection has been linked with a host of systemic effects, including increased insulin resistance (23). Evidence suggests that periodontitis-induced bacteremia will cause elevations in serum pro-inflammatory cytokines, leading to hyperlipidemia, and ultimately causing an insulin-resistance syndrome and contributing to destruction of pancreatic beta cells (10). Insulin resistance leads to a loss of glucose uptake and therefore leads to a hyperglycemic state that can last for weeks after an infection (24). Hyperglycemia, elevated blood glucose, causes pancreatic B-cells to become over stimulated and eventually leads to their dysfunction (1). B-cell dysfunction diminishes cellular glucose uptake and causes loss of glycemic control (1).

Periodontal disease leads to diabetic complications. Although much more information is focused on how diabetes leads to periodontal disease, some studies have focused on the converse relationship. A 2-year longitudinal study demonstrated a sixfold increased risk of decreased glycemic control over time for people with diabetes and periodontal disease, when compared to people with diabetes without periodontal disease (25). Other diabetic complications may be present in people with severe periodontitis. One longitudinal case study found that 81% of people with diabetes and severe periodontitis experienced the onset of at least one major vascular (cardiovascular, cerebrovascular, or peripheral vascular) event compared to only 21% of people with diabetes but without periodontal disease (26). Another longitudinal study examined overall mortality and vascular related disease in over 600 people with diabetes (27). Diabetic nephropathy was 8.5 times higher in the group with severe periodontitis and the death rate from ischemic heart disease was also 2.3 times higher than the group without severe peritonitis (27). The cardio-renal disease in the severe periodontitis group was likewise 3.5 times higher than in people with diabetes but without severe periodontitis (27). Since a possible link between periodontal disease leading to loss of glycemic control and other diabetic related complications has been under investigation, research has been initiated to examine how treating periodontitis might effect glycemic control.

Effect of periodontal disease treatment on glycemic control. Conflicting data make a definitive correlation between treatment of periodontal disease and loss of glycemic control skeptical at this point. Some studies have found significant correlation between periodontitis treatment and glycemic control. For example, a combination of scaling and root planing, in conjunction with doxycycline therapy, has been associated with an improvement in periodontal status which was accompanied by significant improvement in glycemic control, as measured by HbA_{1c} levels (28-30). However, a recent study found that when people with type 2 diabetes were treated as described above, and did have significant periodontal improvement, there was no significant improvement in HbA_{1c} (31) . Variation among studies, subjects studied, and results obtained have therefore created a need for more research to determine whether treating periodontal disease improves diabetes outcomes.

Stress and diabetes. Stress, whether physical or mental, causes the body to believe it's under "attack". High stress levels in turn trigger the fight-or-flight response, which causes many hormones to be released, which are capable of priming the body (1). Hormones allow the body to prepare itself for stressful events by releasing stored energy, making glucose available for cells so that intense levels of activity are capable (1). A life with high-stress levels can be a major complication for people with diabetes because glucose uptake into cells is compromised and a hyperglycemic state is maintained. Therefore, stress-reduction can lead to a decrease in hyperglycemia because stores are not as abundantly released into the blood. Controlling the blood glucose level is key to controlling the diabetes and therefore may also be key to preventing periodontal disease in people with diabetes.

Mindfulness-based stress reduction. A new approach for self-regulatory stress reduction known as Mindfulness-Based Stress Reduction (MBSR) is being employed by some in an attempt to reduce stress. MBSR is a meditation technique that promotes relaxation through the nonjudgmental awareness of moment-to-moment sensations, experiences, and reactions. Becoming mindful allows participants to become aware of decisions they are making and cues that are felt in the body. This technique is possibly an effective way to reduce stress. For example, one version of MBSR was found to significantly reduce the stress levels of medical students when used over a 10-week period (32). Previously, people using MBSR have effectively reduced their stress levels, and therefore MBSR may likewise be an effective way for people with diabetes to reduce stress and thereby better glycemic control.

METHODS

Hypothesis: Similar test groups were set up and participants were randomized to one of two educational groups: (1) the Mindfulness Based-Eating Awareness Therapy group; or (2) a standard nutrition education group. There will be a greater improvement in glycemic control (as measured by HbA_{1C}) in adults with T2DM for the MB-EAT group compared to standard nutrition intervention group.

Inclusion Criteria: Those eligible for the study were men and women aged 35-65 years who have been diagnosed with type 2 diabetes for at least 1 year, who did not require insulin treatment. To be included, participants also had a Body Mass Index greater than 27.0 and HbA_{1c} levels $\geq$ 7.0%. Participants were willing to not engage in any other formal weight loss programs; furthermore participants on medication that could effect outcome variables maintained a stable dose throughout the duration of the study.

Exclusion Criteria: The exclusion criteria for the study were as follows: (1) persons with prescribed insulin therapy, (2) persons with co-morbid psychiatric conditions (i.e., drug abuse, suicidal ideation, psychosis) that would complicate group participation, (3) concurrent participation in another weight loss program during the course of the study, (4) unstable medical conditions or underlying weight problems (thyroid disorder), (5) pregnancy or breast feeding, and (6) unwillingness to be randomized to differing treatment groups.

Recruitment: The OSU Primary Care Practice-Based Research Network, a member of the Agency for Health Research and Quality PBRN registry, was utilized to recruit subjects to this study. The OSU-PCPBRN consists of 19 clinical primary sites including general internal medicine, sports medicine, family medicine, and occupational medicine. OSU-PCPBRN provides care to over 6,000 patients with diabetes and is located throughout Franklin County, Ohio which serves a diverse population. The primary site of the study is the OSU Rardin Family Practice Center. The Rardin Center uses the same medical record systems and abides by the same protocols as larger practice networks. The Rardin Center has nearly 49,000 patient visits a year, 8% of which are for diabetes-related treatment. The Rardin Center serves nearly 900 patients with diabetes, which are made up of a diverse population of overweight and obese people, some who are in poor glycemic control and could benefit from additional intervention education. The OSU-PCPBRN includes a registry with over 6,000 patients with diabetes, 95% of which have type 2. Those patients 35-65 years, diagnosed with type 2 diabetes for greater than 1 year, and having a BMI greater than 27.0 and an HbA_{1c} greater than 7.0% received a letter regarding the proposed study. All interested patients who contact the investigators were first screened by telephone, and then by BMI, and HbA_{1c} values. Baseline data was collected and participants were randomized into one of two treatment groups.

Randomization: Participants were randomized into one of two treatment groups using block randomization. The block randomization was done within race to provide balanced samples in the differing treatment groups. According to enrollment, participants were grouped into 7 blocks and each block was split randomly into either group assignment. A non-study person determined which of the groups was assigned as treatment 1 and which was assigned as treatment 2 with the flip of a coin.

Intervention 1: Mindfulness Based-Eating Awareness Therapy (MB-EAT) is a multifaceted intervention approach that incorporates meditation intervention, along with mindful eating, body awareness, and incorporation of physical activity into a small group setting over a 10-week period. Cultivation of "inner wisdom" which relates to mindfully being aware of what one is eating, as well as "outer wisdom" which is knowledge of food content and diabetes related needs, are the main goals of the intervention. Participants were taught standard nutrition guidelines and also how to practice noticing hunger and satiety cues in an effort to thwart overeating. Many forms of meditation were used, one of which is general mindfulness mediation. This was used to train participants to simply notice without judgment the sensations of their physical body, as well as thoughts and emotions. A second type of meditation was guided eating meditation. The goal of this meditation was to teach participants to notice their own experiences, including behavior and emotional sensation, while they are consuming certain food items. Other guided meditation such as forgiveness meditation, wisdom meditation, and emotion meditation were employed by the MB-EAT intervention group. In addition to meditation training, participants received instruction in standard nutritional education. Therefore, MB-EAT participants receive an intervention consisting of diabetes and nutrition education supplemented by mindful meditation practice in an effort to enhance the effects of controlling their diabetes.

Intervention 2: The second group consisted of a similar program of 10-weeks of intervention but without training in mindful meditation, called the Smart Choices intervention. This standard nutrition group was held under similar circumstances including group settings, with the same nutrition content. The context of the standard nutrition group addressed key aspects of nutrition and physical activity as established by the American Diabetes Association (33). The main areas of focus were relation between diet and glycemic control, portion control, type of carbohydrate, type and amount of fat, cholesterol, dining out guidelines, sample menus, healthy recipes, and physical activity. The education offered was appropriate for weight control and glycemic control for people with diabetes.

Outcomes: Hemoglobin, a major component of oxygen transport in the blood was useful for measuring the effects of the intervention (34). Hemoglobin is present in the blood along with glucose (34). Over time, glucose slowly binds to the circulating hemoglobin which allows for statistical analysis to give an overview of the average blood glucose levels over about the past 2-3 months (34). The glycated hemoglobin, HbA_{1c}, was used to give a broad picture of where a person's blood glucose level was over an extended period of time. HbA_{1c} levels of participants were recorded before and after the 10-week intervention sessions. Comparing the two differing groups change in HbA_{1c} levels allowed for a conclusion to be drawn, whether a mindfulness-based intervention along with nutrition education was a better intervention for controlling diabetes than the standard nutrition intervention. The intervention that achieved the biggest drop in HbA_{1C} is likely a better intervention to reduce the likelihood of periodontal disease in people with diabetes.

Statistical Analysis: Anthropometric and demographic data collected throughout the study were analyzed using SAS JMP (version 8.0, 2008, SAS Institute, Cary, NC). Fisher's exact test or two-sample t-test were utilized to determine if any differences existed between the groups at baseline. The residuals of the data were examined and were not normally distributed for fasting glucose and HbA_{1C}. Likewise, the BMI and weight data for men were also not normally distributed. Upon using analysis of covariance (ANCOVA), similar statistical results were noted while including all subjects and also while excluding outliers. Since exclusion of outliers to normalize the distribution did not affect the statistical significance of the residuals, all subjects' data were included. ANCOVA was utilized for evaluation of both between- and within-group differences. P values < 0.05 are considered statistically significant.

RESULTS

After randomization among those enrolled in the intervention, there were 18 participants randomized to the MB-EAT group and 16 participants randomized to the Smart Choices group. A demographic analysis between the MB-EAT group and the Smart Choices group is presented in Table 1.1. There were no statistically significant differences in outcomes between the two groups after randomization. At baseline, both MB-EAT and Smart Choices groups were similar in weight, waist circumference, BMI, HbA_{1C}, and fasting glucose values (all $P > 0.05$) (see Table 1.2). There was no significant difference between groups in the change in HbA_{1c}. At the conclusion of the 10 week intervention, the Smart Choices group had significant losses within-group in weight, waist circumference, BMI, and HbA_{1C} for both men and women. The MB-EAT group had a significant decrease in HbA_{1C} within-group, but did not have significant changes in weight, waist circumference, or BMI. There was no significant change for either group in fasting plasma glucose.

Variable	MB-EAT (n=18)	Smart Choices (n=16)	P value[a]
	←	(%) →	
Female	61.1	56.2	1.00
White	83.3	81.2	1.00
Hispanic or Latino	5.6	6.2	1.00
Married	61.1	68.8	0.73
Bachelor's degree or higher	38.9	50.0	0.73
Employed full-time	83.3	75.0	0.68
Income ≥ $60,000	44.4	61.5	0.47
Previous diabetes education	70.6	87.5	0.15
Self monitoring blood glucose	70.6	68.8	1.00
Oral Medication usage	94.4	87.5	0.59
Health Insurance	94.4	81.2	0.32
	Mean ± SE	Mean ± SE	
Age (yrs)	54.8 ± 7.56	53.7 ± 6.41	0.64
Years diagnosed with diabetes	7.3 ± 4.41	5.4 ± 3.19	0.14

[a] Using Fisher's exact test, or two-sample t-test for between group comparisons

Table 1.1. Demographic characteristics of adults with type 2 diabetes at baseline

	Baseline			10 Weeks			Change		
Variable	MB-EAT (n=18)	SC (n=16)	P value†	MB-EAT (n=18)	SC (n=16)	P value†	MB-EAT (n=18)	SC (n=16)	P value†
Anthropometric Measurements									
Weight (kg)									
Male	109.34 ± 6.53	114.88 ± 6.53	0.56	107.37 ± 6.53	111.29 ± 6.53	0.68	-1.97 ± 1.02	-3.60 ± 1.02*	0.28
Female	102.97 ± 4.58	104.50 ± 5.06	0.83	102.25 ± 4.59	99.31 ± 5.08	0.67	-0.72 ± 1.06	-5.19 ± 1.18*	0.01
Waist Circumference (cm)									
Male	116.21 ± 5.05	121.44 ± 5.05	0.48	114.57 ± 5.05	117.31 ± 5.05	0.71	-1.64 ± 1.24	-4.12 ± 1.24*	0.18
Female	115.44 ± 3.43	112.32 ± 3.79	0.55	114.67 ± 3.44	107.74 ± 3.80	0.19	-0.77 ± 0.95	-4.58 ± 1.06*	0.02
BMI (kg/m^2)									
Male	33.36 ± 2.16	36.56 ± 2.16	0.31	32.75 ± 2.16	35.41 ± 2.16	0.40	-0.61 ± 0.33	-1.16 ± 0.33*	0.26
Female	37.83 ± 1.89	37.56 ± 1.89	0.92	37.54 ± 2.09	35.72 ± 2.09	<0.01	-0.27 ± 0.37	-1.82 ± 0.41*	0.01
Clinical									
HbA_{1c} (%)	8.49 ± 0.28	8.34 ± 0.30	0.72	7.83 ± 0.29	7.63 ± 0.31	0.65	-0.67 ± 0.28*	-0.71 ± 0.30*	0.91
Fasting Glucose (mg/dL)	180.72 ± 12.05	161.31 ± 12.78	0.28	166.04 ± 12.26	147.13 ± 13.04	0.30	-14.68 ± 10.44	-14.19 ± 11.11	0.97

† Repeated measures for analysis of variance for between group comparisons
* Significantly different from baseline ($p < 0.05$)

Table 1.2. Anthropometric and clinical measurements at baseline and study end (mean ± standard error)

DISCUSSION

About 9.3% of the American adult population, around 19 million people, are living with diabetes (1). With such a large percentage of the population affected, and the number of new cases continually growing, it is now more critical than ever for health professionals to develop effective interventions to combat this disease. Since diabetes is a risk factor for developing periodontal disease (2-7), dental professionals in particular may benefit from understanding the latest and most effective diabetes interventions. Therefore, determining whether diabetes interventions focused on mindfulness based meditation offer a more effective intervention than standard diabetes education is needed.

Better diabetes management is achieved with optimal glycemic control. To obtain an estimate of the average blood glucose over time, health professionals determine the percentage of glycosylated hemoglobin, HbA_{1C}, present in the blood. Higher levels of blood glucose mean more hemoglobin is glycosylated (34). Higher percentages for HbA_{1C} ultimately mean a higher risk for co-morbidities such as periodontal disease (34). Therefore, significant reductions in $HbA_{1C,}$ reduce the risk for periodontal disease.

The Smart Choices group had a significant within-group change in HbA_{1C} following the 10 week intervention, with a mean (±SE) decrease of -0.71 ± 0.30 % ($P = 0.02$). The MB-Eat group had a near identical within-group change over the 10 weeks with a mean decrease in HbA_{1C} of -0.67 ± 0.28 % ($P = 0.02$). Although both groups significantly lowered the HbA_{1C} levels within group, no significant difference in the change in HbA_{1C} was observed between the two groups. Determining the more effective intervention for improving glycemic control was indeterminable since each group experienced similar decreases in HbA_{1C} and no significant difference between groups was observed (P = 0.91). Therefore, both treatments are effective, but the hypothesis that the MB-EAT group would experience a greater improvement in glycemic control was not supported by the findings.

A significant difference in the change in weight, waist circumference, and BMI between women in the Smart Choices group compared to women in the MB-EAT group were noted. Women in the Smart Choices group lost more weight. The Smart Choices group also noted significant within-group losses for men in weight, waist circumference, and BMI. The MB-EAT group did not experience any significant change in weight, waist circumference, or BMI such as the Smart Choices group. Therefore, the Smart Choices (SC) intervention may be more effective in reducing the risk for chronic weight-related diseases.

This study had several limitations that could have an effect on the results obtained. The majority of participants in this study were white (83.3% MB-EAT vs. 81.2% SC), women (61.6% MB-EAT vs. 56.2% SC), with previous diabetes education (70.6% MB-EAT vs. 86.5% SC). The study was implemented among those with poor glycemic control and at greater risk for periodontal disease. The impact of the interventions among samples with differing cultural, educational, and ethnic backgrounds will require further research.

Future research also should assess the condition of periodontal disease among participants. Since periodontal disease is a common co-morbidity of diabetes (2-7), future research should consider how the mechanisms that lead from diabetes to periodontal disease are affected, if at all, by both the Smart Choices and MB-EAT interventions. Monitoring vascular changes, lipid metabolism, collagen synthesis, and neutrophil function while undergoing intervention could give dental professionals evidence for the effectiveness of diabetes interventions in preventing periodontal disease.

Optimal glycemic control is necessary for people with type 2 diabetes to reduce the risk of developing co-morbidities. High glycemic levels can be a result of high stress levels, and utilizing mindfulness may be particularly useful for people with diabetes to reduce their risk for co-morbidities related to diabetes. The mindfulness intervention was equally effective as the standard diabetes intervention at lowering HbA_{1C} . It seems people with diabetes may have several options for combating this disease. Both approaches, MB-EAT and Smart Choices, effectively lowered the within-group HbA_{1C} levels and therefore offer people with diabetes options for achieving optimal glycemic control. In the future, research is needed to evaluate the effect of both treatments on the occurrence and severity of periodontal disease.

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